

**Title:** Constraining the volcanic contribution to Io's atmosphere with ALMA maps

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### Abstract

Io's atmosphere, which requires a continuous replenishment, is mostly likely fed by volcanic plume outgassing and SO<sub>2</sub> frost sublimation, but the relative contributions of the different sources is still poorly understood. One way to retrace the atmospheric origin is to establish with good precision the location of the atmosphere. We used the Atacama Large Millimeter Array (ALMA) to map simultaneously the distribution of SO<sub>2</sub>, SO and KCl. The observations obtained, while achieving only a modest improvement in angular resolution (down to 0.45" in the longitudinal direction), are of much better quality than previous (sub)millimeter maps thanks to the high sensitivity of ALMA. The maps clearly demonstrate that each atmospheric component displays a strikingly different spatial distribution. SO<sub>2</sub>, the main component, appears to be relatively spread out in a latitudinally-bound equatorial band, which is consistent both with previous HST observations and the hypothesis of a mainly sublimation-sustained bulk atmosphere on the day-side. On the other hand, KCl, for which we are presenting the first significant detection, is limited to small unresolved areas. This suggests it is only present in active volcanic plumes and quickly condenses once outside the plumes. Finally the SO distribution roughly traces the spread out distribution of SO<sub>2</sub>, but its offset emission maximum is indicative of an additional distinct source.